Clinical Observations

A Study on the Correlativity of MRI Signal Classifications with TCM Syndromes in Femoral Head Necrosis Patients

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Objective: To probe into the relation between magnetic resonance imaging (MRI) signal classifications and TCM syndromes in femoral head necrosis patients, so as to provide reference for TCM diagnosis of this disease.

Methods: Refering to the criteria for TCM syndrome types of necrosis of the femoral head described in “The Guiding Principles of Clinical Studies of New Chinese Drugs” and Shimizu and Mitchell’s MRI signal classifications, MRI signal classifications between different TCM syndrome types were compared.

Results: The Shimizu signal classification of different TCM syndrome types had statistically significant difference ($P=0.04$); Both T2WI+fs and Mitchell signal classifications of different TCM syndrome types had no statistical by significant differences ($P=0.42$ or $P=0.15$).

Conclusion: There is a certain correlativity of TCM syndrome types of necrosis of the femoral head with T1WI signal classification of MRI. MRI signal classification may contribute to objectivity in TCM syndrome typing of this disease.

Keywords: necrosis of the femoral head; TCM syndrome; imageology

In recent years, although scholars at home and abroad have made a lot of studies on ischemic necrosis of the femoral head, up to mow modern medicine is not yet very clear for the cause and pathogenesis of this disease. TCM holds that this disease is due to deficiency of liver and kidney in origin and blood stasis and phlegm stagnation in superficiality, deficiency in origin and excess in superficiality, deficiency complicated with excess. Imageology with un-replaceable objectivity and sensitivity has important clinical values in diagnosis and treatment of femoral heat necrosis. Since magnetic resonance imaging (MRI) was used in clinic, diagnosis of femoral head necrosis, particularly, the early diagnosis rate has obviously increased. Because the signal changes can directly reflect histological changes, which are closely related with the pathological changes of femoral head necrosis, the advancing stages of femoral head necrosis can be inferred according to the signal changes. It has been put forward that there is correlativity between TCM syndrome types and imageological changes, however, any report about correlativity of MRI as the most sensitive and accurate method for diagnosis of femoral head necrosis with TCM syndromes is not found. In the present study, an attempt is made to probe into the correlativity of MRI signal classes with TCM syndrome types of necrosis of the femoral head, so as to provide references for TCM diagnosis and treatment of femoral head necrosis.

METHODS

Criteria for Diagnosis

In reference to the criteria for diagnosis of femoral head necrosis proposed by specialists in diagnosis and treatment of femoral head necrosis in 2007 and The Guiding Principles of Clinical Studies of New Chinese Drugs (2002 Ed), TCM syndrome types of femoral head necrosis are mainly divided into two types, the tendon-vessel stagnation and the liver and kidney deficiency.

Criteria for Inclusion

Conformed to the criteria of Western medicine for diagnosis of femoral head necrosis; MRI of both hips were taken, and the patient filled two TCM information tables of femoral head necrosis within one month interval.

Criteria for Exclusion

The patients with traumatic necrosis of the femoral head; complicated with other joint diseases, such as bone tumor, rheumatoid arthritis, ankylosing spondylitis, joint tuberculosis, suppurative arthritis; severe congenital deformity of hip joint; had operation of hip joint; complicated with psychosis; or the patient cannot cooperate well.

General Data

Twenty-nine cases (50 hips) of femoral head necrosis were collected by the Outpatient Department of Orthopedics, Guang’anmen Hospital, China Academy of Orthopedics, Guang’anmen Hospital, China Academy of Chinese Medical Sciences, Beijing 100053, China Correspondence to: Prof. XIE Li-min, Tel.: 86-10-88001130, Email: drxlm@2126.com
Chinese Medical Sciences. Among them, 19 cases were male and 10 cases female; single hip affected in 8 cases and both hips affected in 21 cases. They aged between 21–74 years, averaging 45.24±14.33 years; duration of illness was between one month and 5 years with a mean of 13.97±14.06 months. Among them, 12 cases (41.38%) were alcoholic necrosis of the femoral head, 13 cases (44.83%) were hormonal necrosis of femoral head, and 4 cases (13.79%) were idiopathic necrosis of the femoral head. Among the 29 cases, 14 cases were the tendon-vessel stagnation type, and 15 cases were the liver and kidney deficiency type. Among the 14 cases with tendon-vessel stagnation, 10 cases were male and 4 cases were female; among the 15 cases with liver and kidney deficiency, 9 cases were male and 6 cases were female. For the tendon-vessel stagnation type, 5 cases were in single hip and 9 cases were in both hips; and for the liver and kidney type deficiency type, 3 cases were in single hip, and 12 cases were in both hips. There were no statistically significant differences in age (t=1.26, P=0.22), duration of illness (t=1.44, P=0.16), cause of disease (χ²=0.04, P=0.98) and ARCO staging (Z=-1.15, P=0.25) between the two types.

Signal Classification of MRI in T1 Weighted Image (T1WI)

According to the Shimizu’s method, the signals were divided into α, β, and γ. α: The coronary position manifested as a high signal in the T1 weighted image. β: The coronary position manifested as a mixed signal in the T1 weighted image. γ: The coronary position manifested as a low signal in the T1 weighted image.

Signal Classification of MRI in T2WI+fs

In reference to the Shimizu’s method, the signals were divided into I, II, and III. I: The coronary position manifested as a high signal in T2WI+fs. II: The coronary position manifested as a mixed signal in T2WI+fs. III: The coronary position manifested as a low signal in T2WI+fs.

Combined Classification of T1 and T2

In reference to Mitchell method, MRI signals were divided into A, B, C, and D in the combined T1 and T2 weighted image. Type A: T1WI was a high signal, T2WI was a middle signal, similar to change of lipid signal, seemingly representing the early stage of lesion. Type B: Both T1W1 and T2W1 were high signals, similar to changes of sub-acute hemorrhage. Type C: T1W1 was a low signal and T2W1 was a high signal, similar to signal characteristics of liquid. Type D: Lesion-like showed low signals in both T1W1 and T2W1, representing changes at late stage. The signal characteristics of fiber-like tissue were formed by fiber tissue, scar and osteosclerosis.

Criteria for TCM Syndrome Types

In reference to The Guiding Principle of Clinical Research of Chinese New Drugs (2002 Ed), TCM syndromes of femoral head necrosis were divided into two types, tendon and vessel stagnation, and liver and kidney deficiency. For the tendon and vessel stagnation type, the main symptoms: local pain, limited movement, limping; secondary symptoms: rigidity of the lip and knee, pain during movement, redder tongue property or with ecchymosis, thin and yellow fur, taut pulse. For the liver and kidney deficiency, main symptoms: local pain, limited movement, limping, myoatrophy of the affected limb; secondary symptoms: weakness in loin and knee, no strength in walking, dizziness, redder tongue proper with thin and white fur, and taut and fine pulse.

Statistical Processing

The data were processed with SPSS12.0 software. T-test was used for comparison of age and duration of illness between the two syndrome types, rank test for comparison of ARCO stages between the two syndrome types, and Chi-square for comparison of sex and MRI signal types between the two syndromes types. All tests were adopted on both sides. P<0.05 was regarded as statistically significant difference.

RESULTS

Analysis on Correlativity of TCM Syndrome Types with Shimizu Signal Classification

In the analysis on correlativity of TCM syndrome types with Shimizu signal classifications, the test on both sides showed χ²=3.90, P=0.42 (>0.05), indicating that there were no significant differences between different TCM syndrome types in T2WI+fs signal classification (Table 2).
Generally, it is considered that lipids-like signals are stagnation type most frequent as lipids-like signals. Signals of femoral head necrosis of the tendon and vessel indicate lipids-like signals. It can be seen that MRI a middle signal (T2WI+fs being a low signal), which all classification, i.e., T1WI being a high signal, T2WI being and most manifested as A class signal in Mitchell signal classification between different TCM syndrome types in both Shimizu signal classification, the test of both sides showed $\chi^2=9.52$, $P=0.15 (>0.05)$, indicating that there were no significant differences between the different TCM syndrome types in Mitchell signal classification (Table 3).

### Table 2. Comparison of T2WI+fs signal classification between the TCM syndrome types of femoral head necrosis

<table>
<thead>
<tr>
<th>Type</th>
<th>Cases</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>I+II</th>
<th>I+III</th>
<th>II+III</th>
<th>$\chi^2$</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendon and vessel stagnation</td>
<td>14</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver and kidney deficiency</td>
<td>15</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>3.90</td>
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<td>Total</td>
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<td>5</td>
<td>15</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
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</tr>
</tbody>
</table>

### Table 3. Comparison of Mitchell signal classification between TCM syndromes of femoral head necrosis

<table>
<thead>
<tr>
<th>Type</th>
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<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>A+B</th>
<th>A+C</th>
<th>A+D</th>
<th>B+C</th>
<th>B+D</th>
<th>C+D</th>
<th>$\chi^2$</th>
<th>P</th>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>9.52</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>Liver and kidney deficiency</td>
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<td>5</td>
<td>1</td>
<td>3</td>
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<td>13</td>
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<td>5</td>
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<td>2</td>
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<td>2</td>
<td>0</td>
<td>2</td>
<td>9.52</td>
<td>0.15</td>
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**DISCUSSION**

Modern TCM has more and more researches on TCM syndromes of the femoral head necrosis, with varied methods of syndrome classification, but with no unified criteria. Some scholars hold that the syndromes should be classified according to causes of this disease, or according to stages of this disease; and some scholars put forward that there is correlativity of imageological changes with TCM syndrome types, so combination with imageological manifestations to make syndrome typing can more conveniently guide clinical practice. MRI is the most sensitive and the most accurate imageological way for diagnosis of femoral head necrosis at present. At the same time of reflecting morphologic changes of the femoral head, it can reflect histological changes of ischemic necrosis of femoral head, and it has superiority in reflecting early lesion and pathological development and changes of femoral head necrosis as compared with X-ray. Therefore, in this study, MRI was used as imageological way to probe into correlativity between TCM syndrome types and imageological changes, so as to provide a clinical guidance for TCM syndrome typing and TCM treatment of this disease.

It was found for the present study that there was a statistical significant difference in Shimizu signal classification between different TCM syndrome types ($P=0.04$); while there were no statistically significant differences between different TCM syndromes in both T2WI+fs and Mitchell signal classifications. Femoral head necrosis of the tendon and vessel stagnation type most manifested as $\alpha$ signal in T1WI, i.e., high signal, and most manifested as $A$ class signal in Mitchell signal classification, i.e., T1WI being a high signal, T2WI being a middle signal (T2WI+fs being a low signal), which all indicate lipids-like signals. It can be seen that MRI signals of femoral head necrosis of the tendon and vessel stagnation type most manifest as lipids-like signals. Generally, it is considered that lipids-like signals are changes of early signals of femoral head necrosis. This is very similar to the pathologic product of phlegm or disease-inducing factors in TCM. The initial cause of this disease is formation of phlegm, which leads to abnormality of blood lipids and blood rheology, and further induces blood stasis, i.e., the phlegm inducing blood stasis, phlegm stagnation and blood stasis, both jointly induce this disease. Song, et al. analyze substance basis of phlegm stagnancy and blood stasis from biochemical point of view and hold that disturbance of lipids metabolism is cause of the phlegm-stasis disease; because phlegm and blood stasis are homologous, treating phlegm can remove blood stasis. Chen, et al. put forward that blood circulation basis of phlegm syndrome is changes of blood lipids and blood rheology, obviously manifesting as increases of blood consistency, viscosity, aggregation and coagulability. At the same time, increase of lipoproteins can raise electrophoretic migration rate of red cells and serum electroconductivity, and increase blood viscosity, further accelerating aggregation of platelet and inducing blood stasis, that is, phlegm induces blood stasis. Phlegm is the initial pathological product of this disease, while blood stasis is secondary product of phlegm and is final pathogenic factor of this disease. In this study, it was found that changes of MRI signals of this disease at early stage showed lipids-like signals as main, which is very similar to the pathologic product of phlegm or pathogenic factors in TCM, and is uniform with results of previous pathological research of this disease. Also, it is indicated that tendon and vessel stagnation is main manifestation of TCM syndromes of this disease at early stage, but the initial pathological product of this disease is phlegm, and stasis and stagnation of tendon and vessel really is caused by phlegm. However, MRI signals of femoral head necrosis of the liver and kidney deficiency type most showed mixed signals, and next, lipids-like signals. TCM holds that liver and kidney have a common source, mainly referring to essence and blood have a common source, essence and blood transform mutually.
Blood is stored in the liver and the essence in the kidney, essence can produce blood, blood can transform into essence, essence and blood can produce and transform each other. TCM holds that the kidney is in charge of the bone, vital essence forms marrow and the marrow nourishes the bones. When the kidney-essence sufficiency the bones are nourished, hence solid and forceful. On the contrary, insufficient kidney-essence may induce hollow marrow, the bones can not be nourished, hence atrophic debility of bones. Modern Traditional Chinese Medicine that deficiency of liver-yin and kidney-yin, that is, proliferative and differential abilities of marrow stem cells and osteogenic ability decrease, necrotic bones are incompletely repaired, neonatal granulation and necrosis fat commonly occur, so most manifest as the mixed signals in MRI.

In TCM, formation of the phlegm is closely related with functional activities of the spleen and kidney. The spleen has the function to transport and transform nutrients; failure in transporting and transforming nutrients may induce retention of water in the body, coagulating as phlegm. The kidney controls urination and defecation, insufficient kidney-yang may cause difficulty in urination and defecation with upward invasion of water, aggregating as phlegm; and decline of the fire from the gate of life is unable to warm the spleen-yang, and unable to transform foodstuff into nutrients, promoting production of dampness which may be transformed into the. Spleen and kidney support and promote each other in physiology and influence each other in pathology. Failure of spleen in transportation and transformation and dysfunction of the kidney in regulation of water metabolism and control of discharge of urine and stool may induce internal phlegm and the phlegm stagnation may induce blood stasis, both the phlegm and blood stasis finally lead to femoral head necrosis. Our previous study\(^1\) was demonstrated that at the early stage of this disease, the drugs for strengthening the spleen, resolving phlegm, activating blood circulation and removing blood stasis may show good effects of regulating lipids metabolism, improving high-aggregative state of blood, effectively control the bone necrotic condition, and promote repair of bone tissues; and that the late stage, the drugs for strengthening the spleen and reinforcing the kidney may inhibit and reverse the tendency of MSCs to fat cell differentiation and turn to differentiation of osteoblast, and the calcium salt on collagenous fibers secreted by osteoblast may gradually deposite, forming obvious calcium node. Along with prolongation of the inducing and culturing time, the calcium nodes gradually increase and enlarge, well complete the late repair of the bone tissues, playing a role of preventing and treating bone necrosis. Therefore, we consider that when the lipid signals appear, that means the early stage of the disease, which should be treated by strengthening the spleen, resolving phlegm, activating blood circulation and removing blood stasis, combined with the method for warming the kidney and reinforcing yang, and qi-fronting, qi-inhibiting and qi-stabilizing, to regulate the microcirculation and promote diuresis. When the model signals appear in MRI, that means the late stage, being late lesion, the method for strengthening the spleen and reinforcing the kidney should be mainly adopted, with the method for resolving phlegm and removing obstruction of collaterals added.

To sum up, the present study suggests that there is a certain correlativity of TCM syndromes of the femoral head necrosis with T1WI signal types of MRI, which is conductive to objectiveness of the TCM syndrome differentiation of this disease. When MRI manifests the lipid signals, the TCM method for invigorating spleen-
qi combined with the method for activating blood circulation to remove blood stasis should be adopted; while if the mixed signals appear, reinforcing the kidney and strengthening the spleen should be the main therapeutic principle.

REFERENCES


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